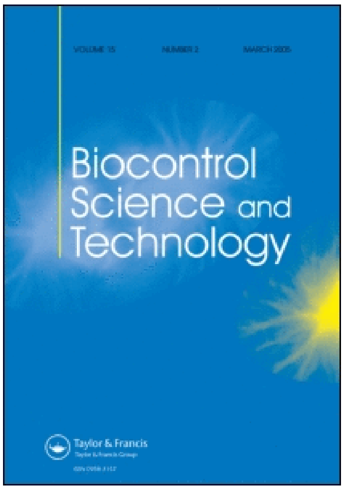

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A survey of fruit-feeding insects and their parasitoids occurring on wild olives, *Olea europaea* ssp. *cuspidata,* in the Eastern Cape of South Africa

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Fruits of wild olives, *Olea europaea* ssp. *cuspidata* (Wall. ex G. Don) Cif., were collected in the Eastern Cape, South Africa, during 2003–2005 to quantify levels of fruit-infesting pests and their parasitoids. Two species of Tephritidae, *Bactrocera oleae* (Rossi) and *B. biguttula* (Bezzi), were the most abundant insects recovered and were reared from most samples. Fruit infestation rates by the *Bactrocera* spp. were generally below 8% and over half of the infestations were under 1%. When parasitism occurred in samples with flies, levels ranged from 7 to 83%. Several species of opiine braconid wasps, *Psyttalia concolor* (Szépligeti), *Psyttalia lounsburyi* (Silvestri), and *Utetes africanus* (Szépligeti) and one braconine wasp, *Bracon celer* Szépligeti, were reared from fruits containing *B. oleae* and/or *B. biguttula*. Chalcidoid parasitoids and seed wasps included seven species of Eurytomidae (*Eurytoma oleae*, *Eurytoma* sp., and *Sycophila* sp.), Ormyridae (*Ormyrus* sp.), Torymidae (*Megastigmus* sp.), and Eupelmidae (*Eupelmus afer* and *E. spermophilus*). One species of moth, *Palpita unionalis* (Hübner) (Crambidae), was recovered in very low numbers and without parasitoids. The survey results indicate that fruit flies might not become economic pests of the nascent commercial olive industry in the Eastern Cape, and the small numbers present may be controlled to a considerable level by natural enemies.

Keywords: olives; *Bactrocera oleae*; *Bactrocera biguttula*; fruit fly; parasitoid; Braconidae; *Psyttalia*; *Bracon*; *Utetes*; biological control

Introduction

Cultivated olives, *Olea europaea* ssp. *europaea* L., have a variety of pests, one of the most serious of which is the olive fruit fly, *Bactrocera oleae* (Rossi) (White and Elson-Harris 1992; Tzanakakis 2003). This fly occurs in sub-Saharan Africa (Lesotho, South Africa, Namibia, Kenya, Eritrea), the Mediterranean region (Egypt, North Africa, southern Europe, Canary Islands), the southern Palearctic and Eurasia (Turkey, the Middle East, Caucasus, Pakistan) (Christenson and Foote 1960; El-Hakim and El-Sayed 1982–1983; Hancock 1989; White and Elson-Harris 1992; Crovetti 1996; Tzanakakis 2003; Copeland, White, Okumu, Machera, and Wharton 2004), and in 1998 it was found in California, where its rapid spread has threatened the state's olive industry (Rice 2000; Collier and van Steenwyk 2003). The fly causes significant damage to olives produced in Mediterranean

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countries (Fimiani 1989; Crovetti 1996). For example, reports of crop loss in Greece from uncontrolled populations of *B. oleae* range from 20 to 30% (Dimou, Koutsikopoulos, Economopoulos, and Lykakis 2003) to as high as 80% in oil-producing areas and 100% in areas where table varieties are produced (Broumas, Haniotakis, Liaropoulos, Tomazou, and Ragoussis 2002). Improved control measures are therefore a priority for the international olive industry. It has been proposed that *B. oleae* is not native to southern Europe but rather Africa or Asia (Silvestri 1915; Nardi, Carapelli, Dallai, Roderick, and Frati 2005). Although this fruit fly can reach damaging levels in commercial olives in South Africa, it appears to be a less serious pest there than in the Mediterranean region, and it has been suggested that natural enemies may be responsible for this difference (Annecke and Moran 1982; Costa 1998).

Hoping to find natural enemies of this pest, Silvestri (1913, 1914, 1916) searched for parasitoids of *B. oleae* in sub-Saharan Africa. From collections of olives in Eritrea he obtained 14 species of parasitoid wasps and returned with 10 of these to Italy but was unable to rear them in Europe, and although small numbers were released, none of them established (Neuenschwander 1982). The North African braconid, *Psyttalia concolor* (Szépligeti), was repeatedly introduced but it did not establish widely in Europe, which was attributed to unsuitable climatic conditions (Raspi and Loni 1994). Neuenschwander (1982) searched in South Africa, where wild olive trees, *O. europaea cuspidata* (Wall. ex G. Don) Cif. (formerly *O. e. africana* (Mill.) P.S. Green (Green 2002)), are widely distributed (Figure 1) and serve as reservoirs for *B. oleae*. His survey of natural enemies in the south-western Cape was productive but he could not establish a culture with the specimens of *Bracon celer* Szépligeti that he shipped to Europe. Exploration conducted in

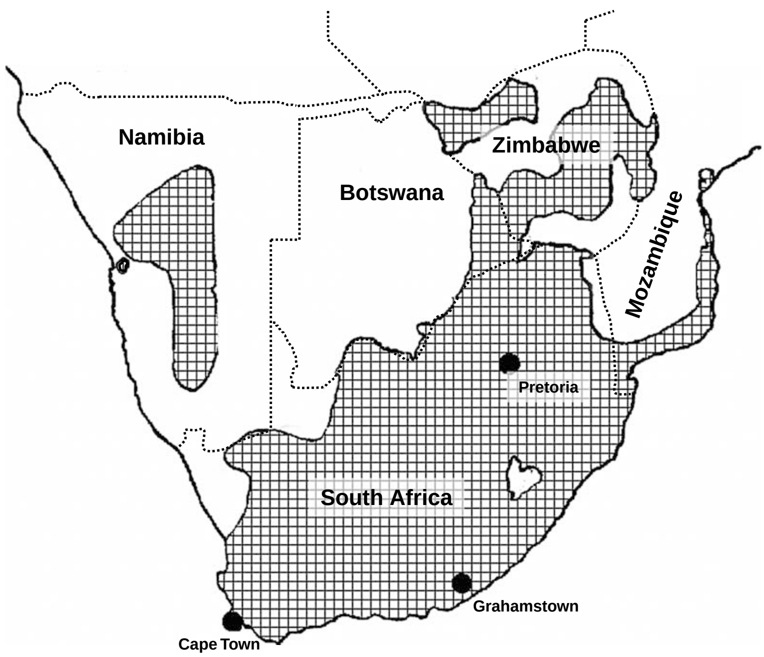

Figure 1. Distribution of wild olives, *Olea europaea cuspidata*, in southern Africa (after Palgrave 2002).

Ethiopia and Kenya in 1975 was unproductive (Greathead 1976). More recently, Copeland et al. (2004) carried out a widespread survey of insects associated with fruits of Oleaceae in Kenya and found *B. oleae* only in fruits of *O. e. cuspidata*. Since the establishment of *B. oleae* in California several years ago new explorations for its natural enemies have been made in South Africa (Western Cape, Eastern Cape, Gauteng, Northwest, and Mpumalanga provinces), Namibia, Kenya, North Africa, Reunion Island, northwestern Pakistan, India and southwestern China (KAH, unpublished information) for possible introduction into California. In South Africa the olive fruit fly and its parasitoids were found in greater abundance in the Western Cape surveys than in the Eastern Cape, but in both provinces a more diverse group of parasitoids was found than in Kenya and Asia. This suggested that more extensive surveys in South Africa were worthwhile, especially since the climate in parts of South Africa is very similar to that of California, so that any new parasitoids would be climatically well adapted if imported.

Although there is a mature olive-growing industry in West Cape, olive culture in the Eastern Cape, which is also within the natural range of the wild olive, *O. e. cuspidata*, was only initiated in 1997 (Hattingh 1998; Zifo 1998; Tamba 2000–2001). This provided an incentive to monitor the insects on olives in the East Cape throughout the olive fruiting seasons, which has not previously been done in this region (Figure 1). Sampling was concentrated on wild olives because most of the commercial plantings in the East Cape were not yet producing fruit.

Materials and methods

Ten sites with wild olives were located in the East Cape for periodic inspection from August 2003 through June 2005; fruit was collected whenever it was present. Nine of the collection sites were situated inland, within 50 km of Grahamstown (Figure 2), between the subtropical and Mediterranean climatic regions. The average temperature of this region is 12.5–15°C in winter (May to July) and 20–25°C in summer (December to February), and the annual total of 250–750 mm of rain falls year-round. In contrast, Ncera Village 6 is close to the coast (Figure 2) and experiences warm humid to hot dry summers and relatively mild winters with warm days and cool nights (Weather SA [=South Africa]). The average temperature is 7–9°C in winter and 25–27°C in summer, and the annual 400–700 mm of rain is moderately erratic and mostly in the form of thundershowers (A. Stylianou, personal communication, 2005). Wild olives were also collected on one date at Goudini Spa (Worcester) in the Western Cape. The Worcester site, which was located about 850–950 km to the west of the Eastern Cape sites, has a Mediterranean climate and commercial olives have been grown in the vicinity for many decades. This site also differed by being located in a region with substantially more wild and cultivated olives than the Eastern Cape locations.

In close proximity to naturally occurring wild olives, cultivated olives were in production at one site (Springvale Farm) in the Eastern Cape. Commercial olives had also been recently planted at several other Eastern Cape sites (Hewlands Farm, Varnam Farm, and around Ncera) but at the latter sites trees were few (<200 per site), young (4–6 years) and had not yet borne fruit. Cultivated olives were sampled at Springvale Farm to provide a comparison with wild olives; sampling was timed to occur before applications of insecticide against olive flea beetles (*Argopistes* spp.).

Green (unripe), partially ripened and fully ripe fruits were collected together directly into plastic bags from trees at random, along with some that had recently fallen, and kept in cooler boxes while in the field. They were promptly taken to the laboratory

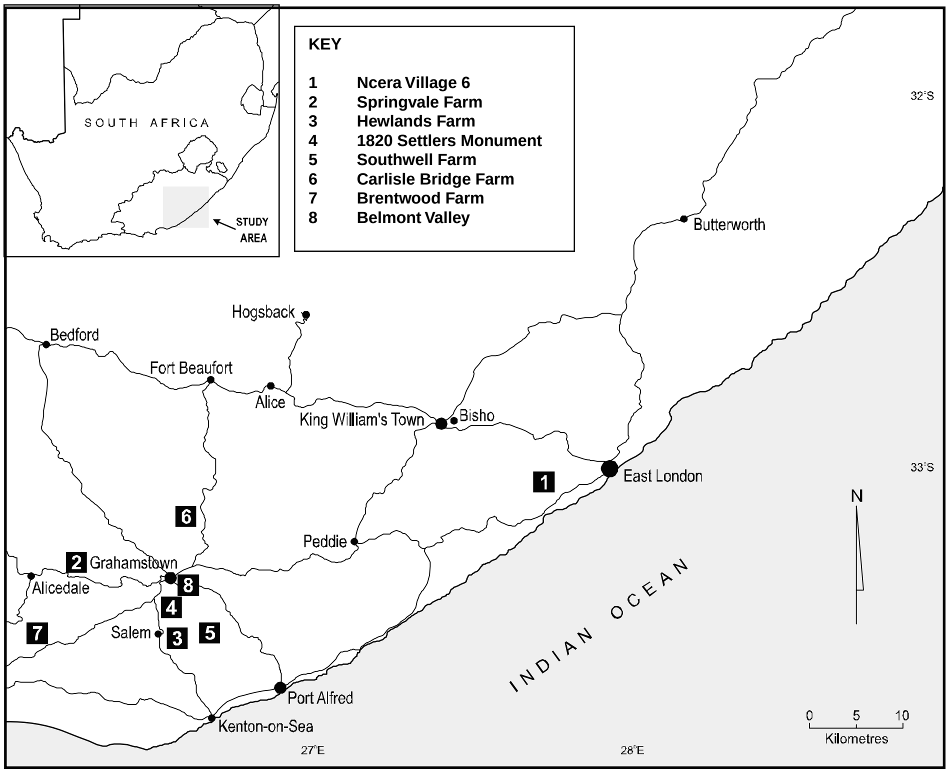

Figure 2. Locations of olive fruit collections in the Eastern Cape, South Africa.

(25°C; 16 h L:8 h D photoperiod) where green fruit was separated from ripe and ripening fruit to provide more resolution to the assessments of insect populations. The fruits were transferred to sieves with holes small enough to retain them but large enough to allow fruit fly larvae and parasitoids exiting the fruit to pass through. The sieves were placed in screened emergence boxes (for ventilation) that had a 2–3-cm deep layer of dry sand at the bottom that absorbed liquid oozing from rotting fruits and served as a pupation site for mature fly and parasitoid larvae. Fly larvae and pupae were retrieved every 2 or 3 days, counted and transferred to well-ventilated Petri dishes maintained at the same environment, and reared until pupation concluded and emergence occurred. The flies and parasitoids that emerged were counted and identified. Flies, their parasitoids, and seed wasps that emerged directly from the fruit were also retrieved and identified.

Percentage infestation was based on the number of *Bactrocera* adults reared and the number of olives collected, using a conservative assumption of one fly per olive. Percentage parasitism was based on the number of adult parasitoids and adult flies reared, also assuming that adult parasitoids occurred one per fly. Whenever fly parasitoids were reared, their numbers were included with the counts of flies to obtain estimates of total infestation by the flies. Voucher specimens have been deposited in the Albany Museum, Grahamstown and the South African Museum, Cape Town.

Results and discussion

Fruit collections

Over 62,000 wild olive fruits were collected in 22 samples from 11 sites beginning August 2003 and continuing through June 2005. Two-thirds of the fruit sampled was green (mean fresh weight of 0.237 g per fruit) and one-third ripe (0.246 g per fruit mean fresh weight). Collections sometimes consisted of entirely green or ripe fruit, while others included both types that were subsequently sorted and divided into green and ripe lots in the laboratory. Flies were reared from collections at eight sites and parasitoids were obtained from four of these sites (Tables 1–3). Fruiting of wild olive trees in the Eastern Cape was highly variable and in 2004 they bore few or no fruit throughout most of the province. The following year there was a substantially larger crop, but the fruiting season began several weeks earlier. For example, fruit was available at Hewlands Farm in August 2003 and February 2005, but none in March 2004. However, in both 2004 and 2005 large fruit crops were obtained from wild olive trees at one exceptional site, Springvale Farm, where the fruiting season ran from April to August in 2004 and from March to June in 2005. Many wild trees on this farm were located adjacent to a stream, and these trees produced heavier crops than trees located further away from the stream. Four species of parasitoids were reared at Springvale in 2004, but in 2005 only one species was recovered. In contrast to the wild olive samples, no flies or parasitoids were recovered in 2004 or 2005 from samples of nearly 8,000 cultivated olive fruits from Springvale Farm collected on six different dates in May, June, July and August 2004 and May and June 2005. The residual effects of applications of insecticides against flea beetles in the orchards may have prevented attack or successful development of flies. Thus, all olive rearing results discussed hereafter pertain to wild olive samples.

In addition to wild olive samples, one collection of fruit was taken from *Jasminum multipartitum* (Hochst.) at Ncera Village 6 that was growing next to wild olive trees; this species is also a member of the family Oleaceae, and its fruit closely resembles that of *O. e. cuspidata*.

Fruit flies

Two *Bactrocera* species, *B. oleae* and *B. biguttula* (Bezzi), were collected. In the Eastern Cape samples, *B. biguttula* was three times as abundant as *B. oleae* (421 vs. 142 adults reared). Only *B. oleae* was reared from the single sample from Worcester ($n = 49$). *Bactrocera oleae* was reared from collections at 6 sites; *B. biguttula* from collections at seven sites (Table 1). *Bactrocera oleae* was the only fly obtained from seven of the samples/subsamples, *B. biguttula* was the only fly in nine, and both species were reared from 10 samples/subsamples. Apart from several exceptional infestations of 14% (Hewlands, 'green' wild olives on 20 August 2003) and 22% (Grahamstown 1820 Settlers Monument, 'ripe' wild olives on 31 May 2005), less than 8% of wild olive fruits in any sample were infested by flies, whether green or ripe fruit, and more than half of the infestation rates were below 1%. Mean sample infestation rates were 2.6 and 1.8% for *B. oleae* and *B. biguttula*, respectively. It is possible that rearing was not 100% efficient and that some flies and parasitoids died without emerging, so rearing results may have underestimated true infestation levels. Three sites with olives obtained only in early season (consisting of green fruits collected in February 2005) yielded no flies at all. Sample dates from which flies were obtained ranged from 29 March to 20 August; this range was the same for both *Bactrocera* species. The Worcester sample from the West Cape, collected on 12 January 2005, was an

Table 1. *Bactrocera* species reared from fruit of wild olive, *Olea europaea* ssp. *cuspidata*, from seven sites in the Eastern Cape and one collection from the Western Cape, 2003–2005. No flies were reared from collections at other survey sites.

Site & Sample date(s)	No. of fruit	Fruit maturity	Fly sp. reared	No. reared	Apparent infestation rate (%)
Hewlands Farm					
20/08/03	49	green	*B. oleae*	4	8.16
			B. biguttula	3	6.12
Springvale Farm					
15/05/04	5042	green	*B. oleae*	5	0.18
09/06/04	7112	green	*B. oleae*	3	0.18
	841	ripe	*B. oleae*	19	3.80
12/07/04	6725	green	*B. oleae*	4	0.16
	2858	ripe	*B. oleae*	5	0.59
12/08/04	677	ripe	*B. oleae*	11	2.07
29/03/05	2800	ripe	*B. biguttula*	36	1.29
27/04/05	1496	green	*B. biguttula*	10	0.67
	1957	ripe	*B. biguttula*	110	5.62
31/05/05	4629	green	*B. biguttula*	5	0.11
	3216	ripe	*B. oleae*	2	0.06
			B. biguttula	89	2.77
22/06/05	1520	green	*B. oleae*	6	0.39
			B. biguttula	3	0.20
	1353	ripe	*B. oleae*	4	0.74
			B. biguttula	21	1.55
Grahamstown (1820 Settlers Monument)					
29/03/05	918	ripe	*B. biguttula*	34	3.70
27/04/05	772	green	*B. oleae*	1	0.13
			B. biguttula	20	2.59
	1073	ripe	*B. oleae*	2	0.19
			B. biguttula	27	2.52
31/05/05	917	green	*B. oleae*	4	0.44
			B. biguttula	4	0.44
	341	ripe	*B. oleae*	68	21.41
			B. biguttula	1	0.29
Ncera Village 6					
25/04/05	626	green	*B. biguttula*	1	0.96
05/05/05	502	green	*B. biguttula*	4	0.80
	1638	ripe	*B. biguttula*	39	2.38
Brentwood Farm					
29/04/05	1099	green	*B. oleae*	3	0.27
			B. biguttula	7	0.64
Southwell					
29/03/05	1597	ripe	*B. biguttula*	5	0.31
Carlisle Bridge Farm					
05/04/05	681	green	*B. oleae*	1	0.15
			B. biguttula	2	0.29
Worcester (Western Cape)					
12/01/05	1512	mixed	*B. oleae*	49	4.37

Table 2. Braconidae reared from *Bactrocera* spp. in fruit of wild olive, *Olea europaea* ssp. *cuspidata*, from three sites in the Eastern Cape and one site in the Western Cape, 2004–2005. No braconids were reared from collections at other survey sites.

Site & Sample date	No. fruit collected	Fly spp. in sample	Braconid spp. reared	No. parasitoids emerged	Apparent parasitoids rate (%)
Springvale Farm					
15/05/04	5042	*B. oleae*	*P. concolor*	1	11.1
			P. lounsburyi	1	11.1
			U. africanus	2	22.2
09/06/04	7953	*B. oleae*	*B. celer*	5	38.5
			U. africanus	18	45.0
12/07/04	9583	*B. oleae*	*U. africanus*	19	67.9
12/08/04	677	*B. oleae*	*U. africanus*	2	14.3
			P. concolor	1	7.1
22/06/05	1353	*B. oleae, B. biguttula*	*B. celer*	6	19.4
Grahamstown (1820 Settlers Monument)					
31/05/05	1258	*B. oleae, B. biguttula*	*U. africanus*	6	7.8
Ncera Village 6					
25/04/05	626	*B. biguttula*	*U. africanus*	5	83.3
Worcester (Western Cape)					
12/01/05	1512	*B. oleae*	*U. africanus*	17	25.8

exception. When numbers of flies were combined across years, rearings of *B. biguttula* exhibited a peak between 120 and 150 Julian days, which was about 1 month earlier than the peak for *B. oleae*. However, only *B. oleae* was reared from the Springvale site in 2004, which was the only site with flies that year. Although our data suggest that *B. biguttula* may be prevalent slightly earlier in the season than *B. oleae*, data from additional years are needed to confirm this possibility.

Even though twice as many green fruits were collected as ripe ones, sorted collections consisting of ripe fruits tended to yield more flies than green fruits, probably because they had been available longer for infestation. More than three times as many *B. oleae* were reared from ripe fruit than from green; this difference was even more pronounced for *B. biguttula,* with seven times as many reared from ripe fruit. Both flies showed similar ranges of infestation levels in collections of green fruit (means of 1.1 and 1.3% for *B. oleae* and *B. biguttula*, respectively) but *B. oleae* had a slightly higher mean infestation rate in ripe fruits than *B. biguttula* (4.1 vs. 2.3%).

Munro (1924) reported that *B. biguttula* pupates inside fruit of other wild *Olea* species when these were held in the laboratory, but noted that in the field larvae drop into the soil. It is not clear to what extent pupation in smaller *O. e. cuspidata* fruit might occur in the field. In contrast, *B. oleae* larvae typically leave the fruit to pupate in laboratory and in the field. There is evidence of intense predation of soil-pupating insects like *C. capitata* and certain moths by ants and spiders in citrus orchards in the Grahamstown area (Bownes

Table 3. Chalcidoid wasps reared from fruit of *Olea europaea* ssp. *cuspidata* from six sites in the Eastern Cape, South Africa and one site in the Western Cape, South Africa, 2003–2005. No chalcidoids were reared from collections at other survey sites.

Site	No. of sample date(s)	No. of fruits collected	Species reared	Total no.	Highest apparent parasitism rate (%)
Hewlands Farm	2	49	*Eurytoma oleae*	3	6.12
Springvale Farm	8	44560	*Eurytoma oleae*	101	1.38
			Eurytoma sp.	1	0.02
			Eupelmus afer	23	0.31
			Eupelmus spermophilus	9	0.43
			Ormyrus sp.	12	0.20
			unidentified chalcidoid	5	0.07
Grahamstown (1820 Settlers Monument)	3	7241	*Eurytoma oleae*	23	5.57
			Eupelmus spermophilus	1	0.29
			Ormyrus sp.	2	0.59
Ncera Village 6	2	4325	*Eurytoma oleae*	19	3.04
			Eupelmus spermophilus	2	0.16
			Ormyrus sp.	2	0.32
Brentwood Farm	2	1278	*Eurytoma oleae*	7	0.64
Carlisle Bridge Farm	2	1068	*Eupelmus spermophilus*	1	0.15
			Ormyrus sp.	1	0.15
			Sycophila sp.	4	0.59
Worcester	1	1512	*Eurytoma oleae*	31	2.05
			Eupelmus spermophilus	201	13.29
			Ormyrus sp.	17	1.12
			Sycophila sp.	8	0.53
			Megastigmus sp.	5	0.33

2002), and fruit fly larvae such as *B. tryoni* (Frogatt), *B. dorsalis* (Hendel) and *Anastrepha ludens* (Loew) are attacked by ants, rove beetles and spiders (Newell and Haramoto 1968; Thomas 1995) when they leave their fruits, particularly in summer. If *B. biguttula* pupae are differentially protected within fruits in the field, it seems possible that the difference in numbers of *B. biguttula* and *B. oleae* at the same sites in the Eastern Cape could be partly due to differential predation on pupae.

Known only from southern and eastern Africa, *B. biguttula* has previously been reported from fruit of *Olea woodiana* ssp. *woodiana* Knobl., *O. capensis* ssp. *capensis* L. and *Chionanthus foveolatus* L. in South Africa (Munro 1984) and *O. woodiana* ssp. *disjuncta* P.S. Green in Kenya (Copeland et al. 2004). In 2005, however, Copeland (personal communication) reared two *B. biguttula* from 22 fruits of *O. e. cuspidata* from collections in Kenya. In our study *B. biguttula* was reared in large numbers from *O. e. cuspidata*, and one specimen was reared from a single collection of 131 *J. multipartitum* fruits, the latter a new host record. Evidence of fruit fly attacks on *J. multipartitum* fruits was also seen on preserved specimens in the Selmar Schonland Herbarium (Rhodes University, Grahamstown) when the plants were identified.

A single female Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), was reared from one sample of green fruit. Medfly has been reported to attack but not develop in cultivated olives in the West Cape (Costa 1998). Several overripe samples also produced a few *Drosophila melanogaster* (Meigen).

Fruit fly parasitoids – Braconidae

Four species of fly parasitoids (Hymenoptera: Braconidae, $n = 83$) were reared from wild olive samples (Table 2). Braconids were obtained from both green and ripe fruit. Because of the possibility of fruit infestation by either species of *Bactrocera* it was not possible to be certain which species hosted the parasitoids. However, most of the braconids ($n = 66$) were reared from samples from which only *B. oleae* adults were obtained, while only five individuals emerged from samples that produced only *B. biguttula.* Twelve were reared from samples that produced both fly species. All the samples that produced only *B. oleae* adults also produced braconids, whereas they were reared from just one of the samples that produced only *B. biguttula*. Since three times as many *B. biguttula* were reared from our samples as *B. oleae*, this suggests that the braconids may be more closely associated with *B. oleae* than with *B. biguttula.*

The opiine braconid *Utetes africanus* (Szépligeti) was the most commonly reared species ($n = 69$: 39 female, 30 male). It was obtained from seven samples and parasitised 7–83% of the fly pupae with a mean rate of 32% (samples with no observed parasitism not included in calculation). Fifty-eight individuals were reared from samples that produced only *B. oleae* adults, six were from one sample that yielded adults of both flies, and five came from one sample that produced only *B. biguttula*. A few individuals of the opiine braconids *Psyttalia concolor* (Szépligeti) and *P. lounsburyi* (Silvestri) were also obtained. Two female *P. concolor* and one female *P. lounsburyi* were reared from three samples that produced only *B. oleae*. The fourth species, *Bracon celer* Szépligeti (subfamily Braconinae) was recovered from two samples at one site ($n = 11$, five females and six males, parasitism rates of 19 and 38%) that produced *B. oleae* only from one sample and both *Bactrocera* species from the other.

Only half of the samples containing flies produced braconids. In these samples the total parasitism by all braconids ranged from 7 to 83%, and the mean number of flies per sample was 40.5. The overall mean rate of parasitized samples was 26%. Braconids were obtained from only three of the seven Eastern Cape sites where flies occurred. Furthermore, a majority of these were obtained from just one of the Eastern Cape sites, Springvale ($n = 55$, 83% of the total reared from Eastern Cape sites). All four species of braconids were reared from Springvale in 2004, but in 2005 only *B. celer* was recovered, on just one sample date. The diversity present at Springvale may have been due to the consistent availability of fruit at this site or the relative paucity of fruit samples from most of the other sites; longer term surveys are needed to clarify this point. There is insufficient information to account for the relative lack of recovered parasitoids during 2005 when olives were readily available at many of the sites in contrast to 2004.

Although *U. africanus* was the most common parasitoid in our samples for the Eastern Cape, it was relatively uncommon in wild olives sampled in Kenya (Copeland et al. 2004). Whereas *P. lounsburyi* was rare in our samples, in Kenya it was dominant wherever parasitoids were reared (Copeland et al. 2004). Neuenschwander (1982) reared only 25 specimens from the Western Cape and Transvaal. *Psyttalia concolor* appears to be rare generally in the Eastern Cape. Similarly, only 10 specimens were recovered from wild olives in Kenya (Copeland et al. 2004). The relative rarity of *B. celer* in the Eastern Cape is comparable to Kenya (Copeland et al. 2004) but contrasts with the results of Neuenschwander (1982), who reared about 350 specimens of *B. celer* from cultivated olive samples in the Western Cape and Transvaal; it was the most abundant parasitoid species reared in his study (the numbers of olives were not recorded). Possible differences in seasonality or climate at the time of collection, differences in types of olives collected, rearing methods and conditions, etc., make it difficult to draw further conclusions from these comparisons among studies without more detailed information.

Other Hymenoptera

Seven species in four families of chalcidoid wasps that are phytophagous on the olive seed, parasitoids of seed wasps, or in a few cases, parasitoids of olive flies (Neuenschwander 1982; Copeland et al. 2004), were reared from wild olives (Table 3). *Eurytoma oleae* Silvestri was the most widespread and abundant chalcidoid reared in the Eastern Cape, followed by an unidentified *Ormyrus* species (Ormyridae) and two species of *Eupelmus* (Eupelmidae). Eurytomids were reared from all but three sites, usually in very low numbers. With very few exceptions, their rates of occurrence were less than 1%. *Eurytoma oleae* was found at six of the nine sites. Its peak infestation rate was 6%, but its median infestation was only 0.4%. Another eurytomid, *Sycophila* sp., was recovered from collections at two sites, once each in the Eastern and Western Capes, at a rate of less than 0.6% of either sample. *Eurytoma oleae* and *Sycophila aethiopica* (Silvestri) were reported from cultivated olives in South Africa by Neuenschwander (1982). *Eurytoma oleae* is phytophagous and develops on the seeds of olives (Silvestri 1915; Neuenschwander 1982). *Sycophila* species are typically parasitic (Noyes 2003) and the *Sycophila* sp. may be a parasitoid of seed-infesting chalcidoids, as postulated for *S. aethiopica* (Wharton 2007).

Some of the other chalcidoids reared may have been either primary or hyperparasitoids of olive fly parasitoids or seed wasps or both, but these details could not be confirmed based on rearings. *Ormyrus* sp. occurred at four sites in the Eastern Cape at infestation rates below 0.5%. *Eupelmus afer* Silvestri and *E. spermophilus* Silvestri were obtained at low rates of infestation, the former in three samples from one site, and the latter in six samples from five sites. *Eupelmus afer* has been recorded as a primary parasitoid of *B. oleae* (Neuenschwander 1982). An unidentified chalcidoid was found at very low rates in two samples from Springvale, and a single specimen of an unidentified *Eurytoma* species was reared from the same site. Most of these chalcidoid species were obtained from both green and ripe fruits, although two-thirds of individuals reared were from green olive collections and the overall emergence rate was 0.04% from green fruit vs. 0.02% from ripe fruit. Aside from the single unidentified *Eurytoma* species, both sexes were obtained of each species.

From the single collection of wild olives at Worcester (Western Cape), five females of *Megastigmus* sp. (Torymidae) were reared in addition to specimens of *E. oleae*, *Sycophila* sp., *Ormyrus* sp. and *E. spermophilus*. The rates of infestation of most of these species were marginally higher than in wild olives in the Eastern Cape and that of *E. spermophilus* was notably higher with a rate of infestation of 13%.

Copeland et al. (2004) reared a diverse assemblage of chalcidoids from wild olives collected in the highland forests of Kenya. In contrast, Neuenschwander (1982) recorded them from only one of seven wild olive collection sites in Western Cape, but reported significant levels of attack by seed wasps (*Eurytoma* spp.) in commercial olives. Costa (1998) reported that seed wasps were common in wild olives but infrequent in olive orchards, where they cause serious damage only occasionally. Given the low rates of infestation we found in the Eastern Cape, seed wasps are of questionable concern as potential olive pests in the region.

Other insects

The jasmine moth, *Palpita unionalis* (Hübner) (Crambidae: Spilomelinae), was reared from green and ripe fruits in very low numbers at three sites. Seven individuals were obtained from a total of 1120 fruits at these sites, giving apparent infestation rates of 0.09–0.80%. Most died as larvae or pupae, and no parasitoids were obtained from moth larvae or cocoons.

Palpita unionalis has been reported to attack wild olives in Southern Africa (Kroon 1999; Vári, Kroon, and Krüger 2002) and was also reared from *Jasminum fluminense* Vell. in Kenya (Copeland et al. 2004). The population densities of *P. unionalis* found on wild olive fruit in our study were relatively low, but Mazomenos, Konstantopoulou, Stefanou, Skareas, and Tzeiranakis (2002) reported that *P. unionalis* is considered to be in high numbers if it attacks the fruit because it is known to be a serious pest that feeds on young leaves and shoots of *Jasminum* sp., *Ligustrum* sp. and *O. e. europaea*. Considering the low numbers that were obtained in this study, *P. unionalis* seems to be of negligible potential economic importance to olives in the Eastern Cape.

Conclusions

The irregularity of fruiting of *O. e. cuspidata* during our survey period, with corresponding variability in numbers of insects reared among samples, suggests that more extensive surveys over longer periods of time are needed to better comprehend the dynamics of fly and natural enemy populations in wild olives. Neuenschwander (1982) also noted the irregular fruiting of wild olives in South Africa. Greathead (1976) was unable to find any wild olive fruits during 2 months of searching in Kenya in 1975. *Olea e. cuspidata* also had irregular fruiting periods in Kenya (Copeland et al. 2004). The unpredictable occurrence of *B. oleae* in wild olives at any given site could be related to either non-fruiting years or the unpredictable fruiting period of wild olive trees (Copeland et al. 2004). Although olive trees can generally survive in dry conditions, the general occurrence of fruits only on trees nearer to the stream at Springvale Farm supports the suggestion that fruiting requires more water (Costa 1998). Certain other species of *Olea* have a highly variable fruit production known as 'mast fruiting', whereby a majority of a species develop mature fruits only in 'mast' years, thought to be a strategy for surviving seed predation (Kelly 1994). A better understanding of fruiting patterns of *Olea* would assist further survey work, and refine our understanding of the phenology of olive-associated insects. Given the unpredictability of fruiting, supplementing field observations with laboratory studies will help determine the relationship between fly preference, fly development and fruit ripeness.

Detailed information about the population ecology of olive fruit pests and associated natural enemies has thus far been available only from studies in southern European olive groves (e.g. Corfu, Greece; Fletcher, Pappas, and Kapatos 1978). Therefore, a great deal of research remains to be done so that South Africa and other countries can improve the management of these pests. The data presented in this study give a preliminary view of olive flies and their parasitoids associated with wild olives in the Eastern Cape. Though the sampling period was limited, the results provide a foundation for additional research which is still needed on the correlation between olive fruit pests and their natural enemies in different South African environments. Neuenschwander (1982) reported considerably higher levels of wild olive fruit infestation in samples from the Western Cape, with lesser levels in commercial olives, and attributed high levels of parasitism in orchards to the regular availability of cultivated fruit. Given the relatively low infestation levels of wild olives in the Eastern Cape, it is possible that flies might not become economic pests of commercial olives in the Eastern Cape, and the small numbers present may be controlled to a considerable level by natural enemies present in wild olives during a large part of the year.

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